



AFRL-RQ-WP-TM-2016-0150

**SLOTTED WAVEGUIDE ANTENNA STIFFENED
STRUCTURES (SWASS) DEVELOPMENT FOR
COMMERCIAL OFF-THE-SHELF (COTS) RADAR
(BRIEFING CHARTS)**

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OCTOBER 2016

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14. ABSTRACT This slide show describes SWASS development.					
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Integrity ★ Service ★ Excellence

RQVS SWASS Development for COTS Radar

7 March 2016

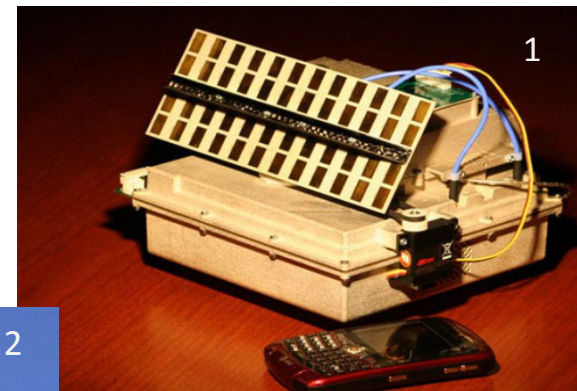
**David Zeppettella
Electronics Engineer
AFRL/RQVS**



SWASS for ImSAR

- NanoSAR : 3 lb., 30 W
- Applications: SAR, FOPEN, MTI
- Frequencies: UHF, L, X, Ku
- Pod mount options: 7-19 lbs

ImSAR Pods ₃



NanoSAR on Scan Eagle

- We have focused on X band SAR and MTI

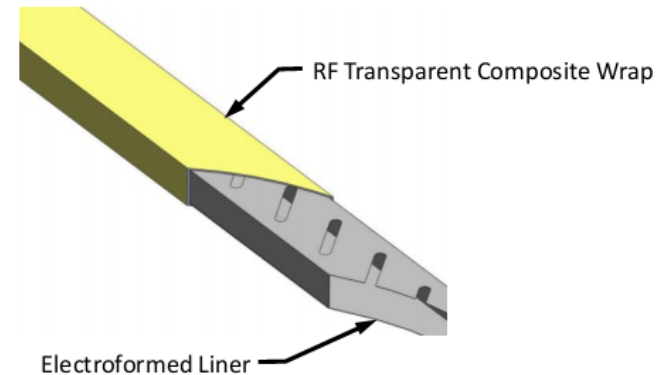
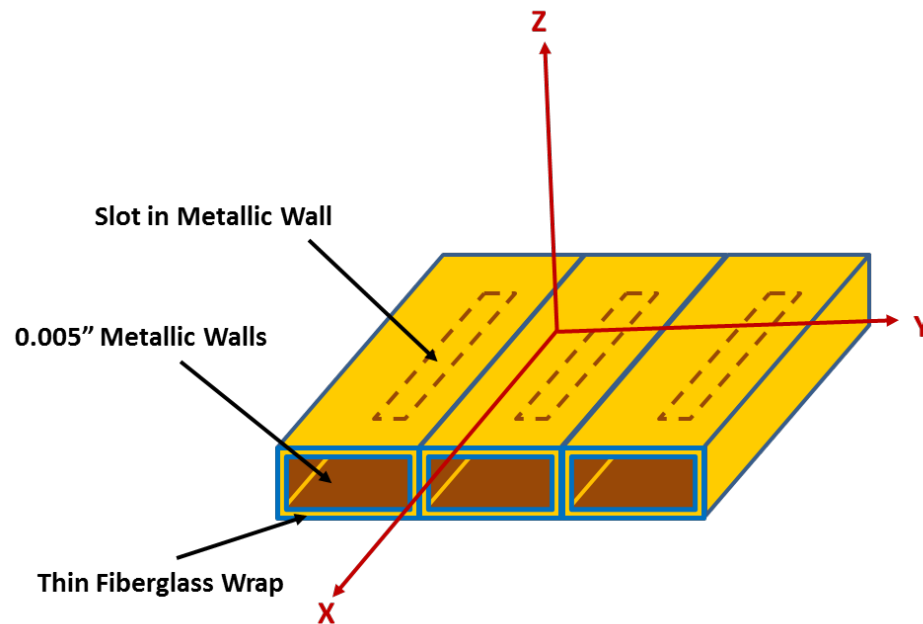
1. <http://www.uasvision.com/2012/06/15/imsar-gets-24m-nano-sar-contract-for-uas-from-us-army/>

2. http://www.barnardmicrosystems.com/UAV/features/synthetic_aperture_radar.html

3. <http://www.imsar.com/pages/products.php?name=nanosar>

4. <http://www.defenseindustrydaily.com/Us-Army-Wants-a-Small-Radar-for-Small-UAVs-07408/>

Fundamental CLAS/SWASS Concept

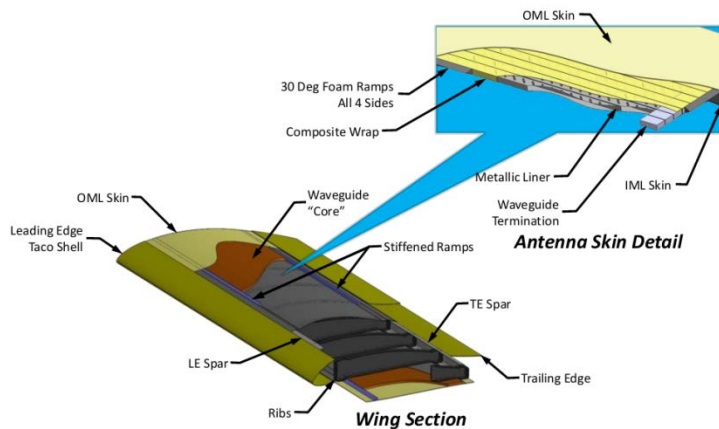
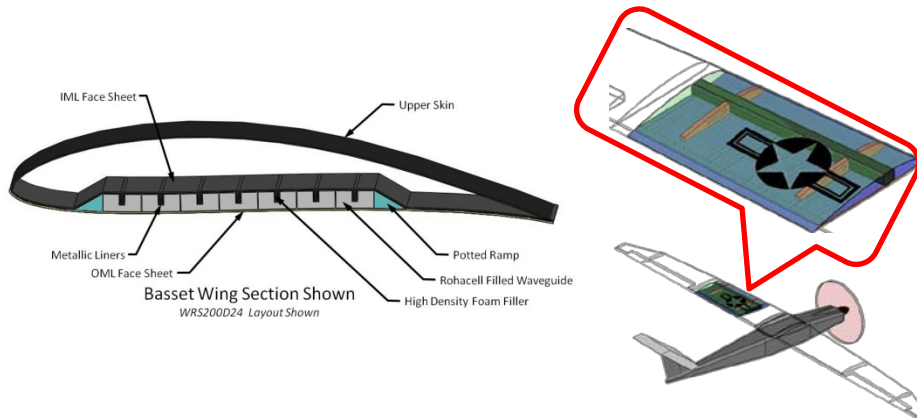


Electroformed Composite Wrapped Waveguide

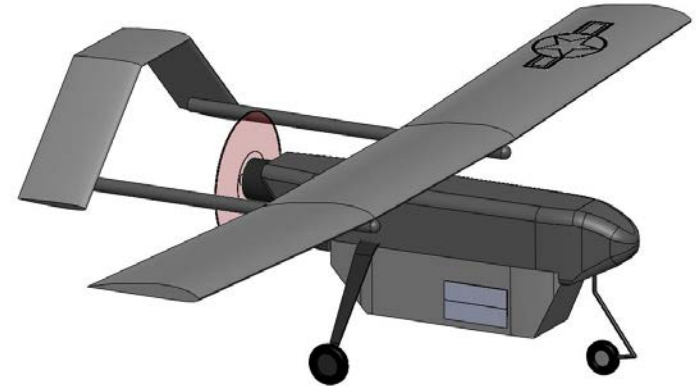
Note: This is applicable for Astroquartz and Glass Fibers

- **Slotted Waveguide Antenna**
- **Lightweight**
- **Structural / Load Bearing**
- **Conformal with airframe body**

Potential CLAS/SWASS Airborne Implementations

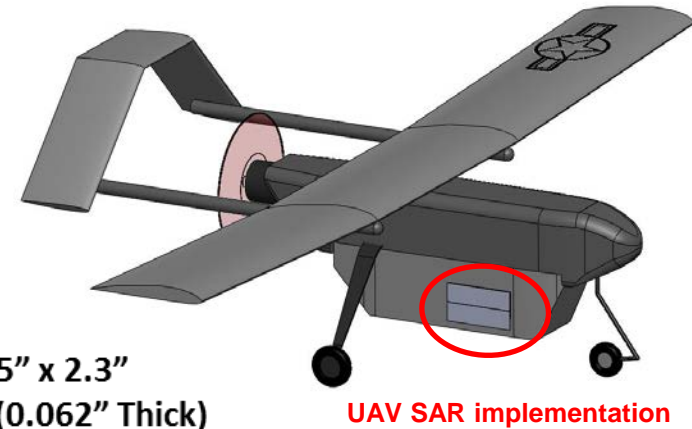
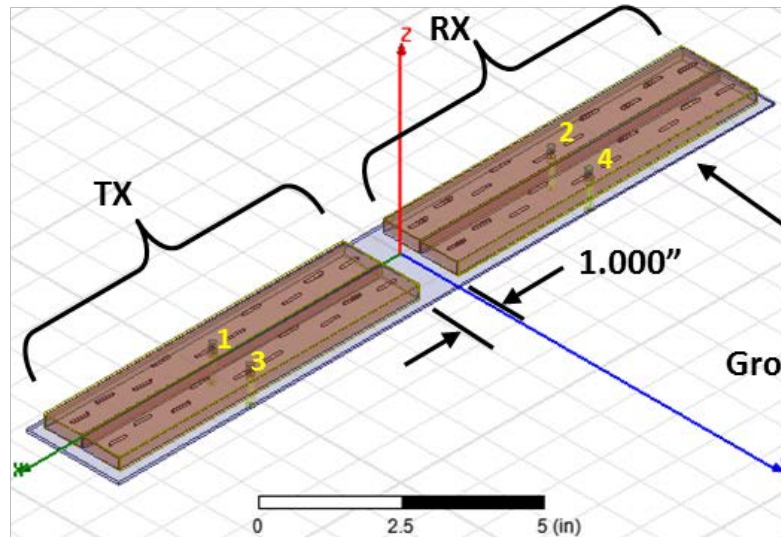


Wing Implementation



Body / Fuselage Implementation

Coax Center-Fed Slotted Waveguide Antenna



Potential Airborne Applications

- Radar (GMTI, SAR, MTI, FOPEN)

Advantages

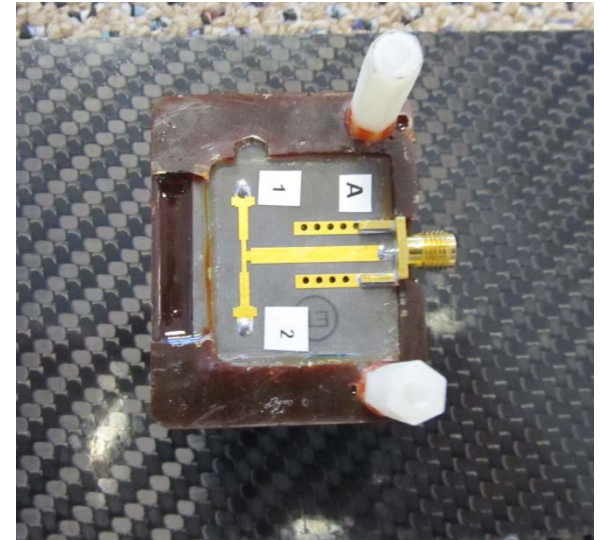
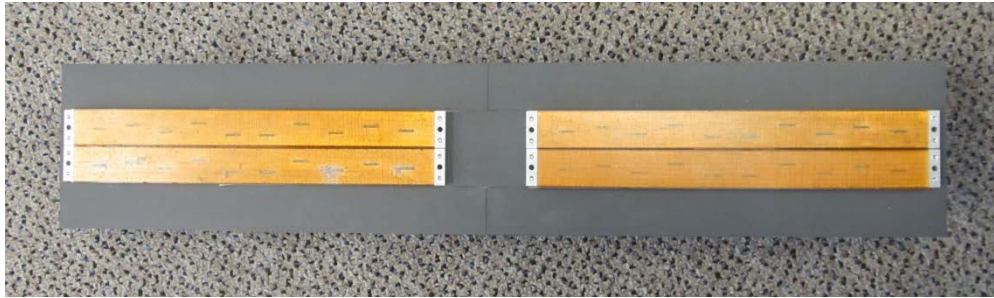
- Low to moderate loss
- Little touch labor
- Decent control of side lobes
- Very low X-Pol
- Can be adapted for 1-D scanning
- Moderate to high power capability
- Ability to scale to large apertures

Disadvantages

- Narrow banded (5% to 10%)
- Lack of 2-D scanning capability
- Lossy combiner network (unless manufactured with waveguide technology)

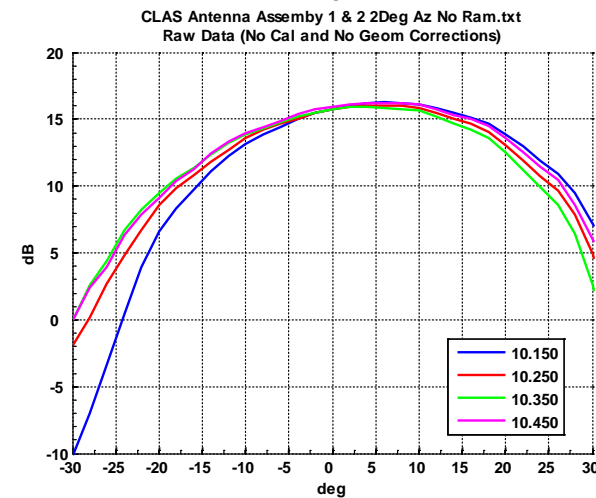
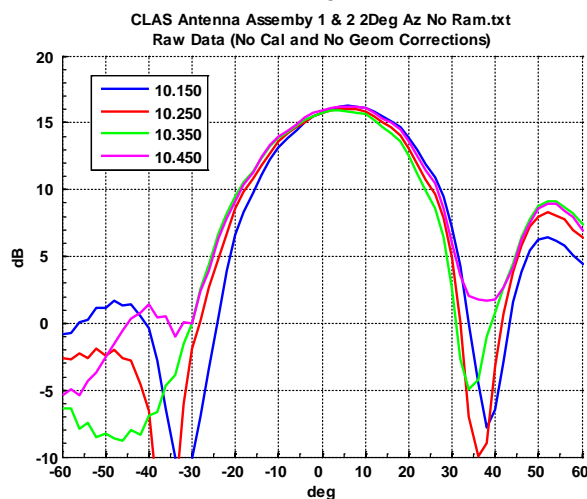
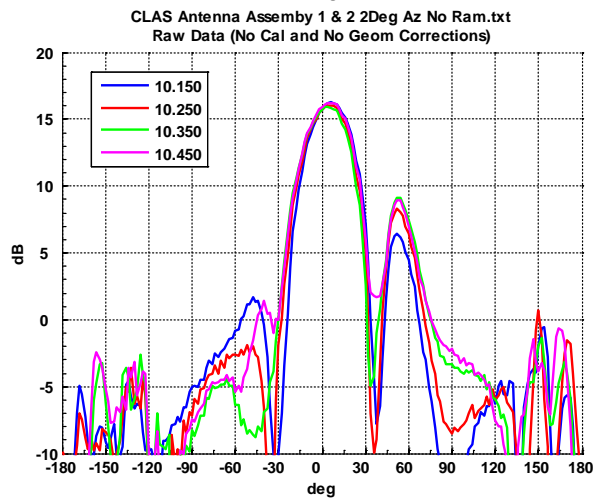
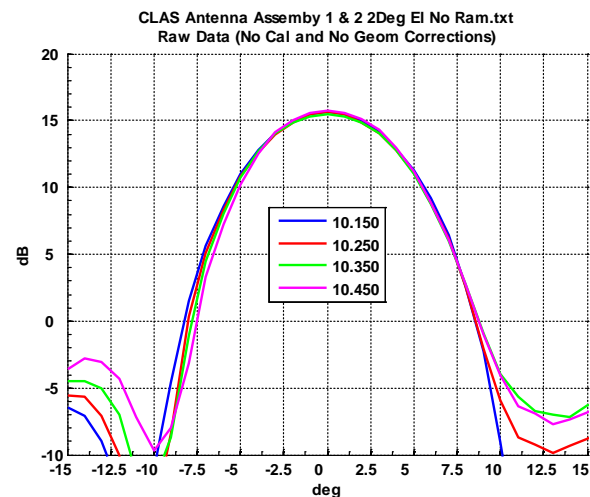
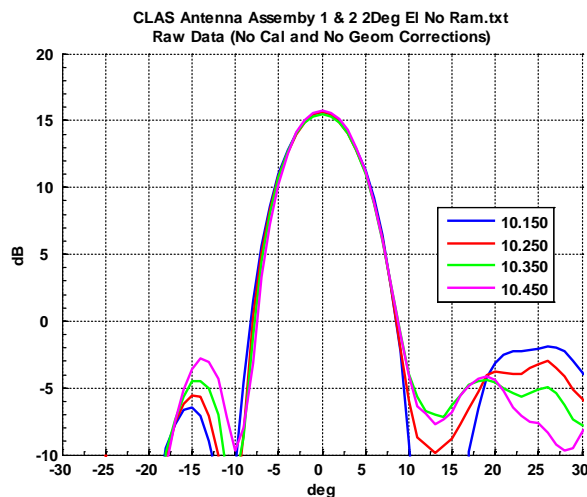
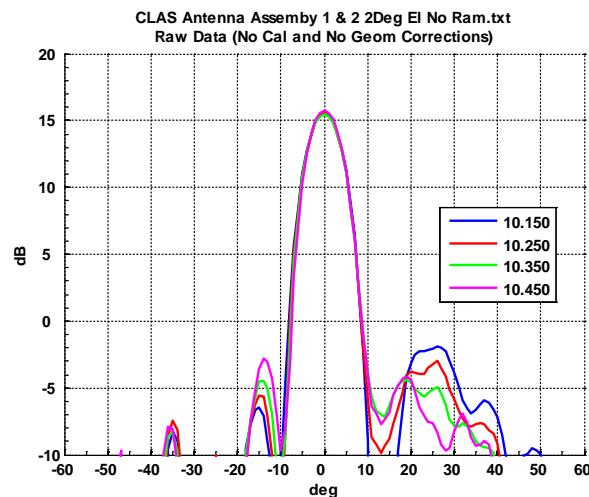
BRC NanoSAR Demo

2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



BRC NanoSAR Demo

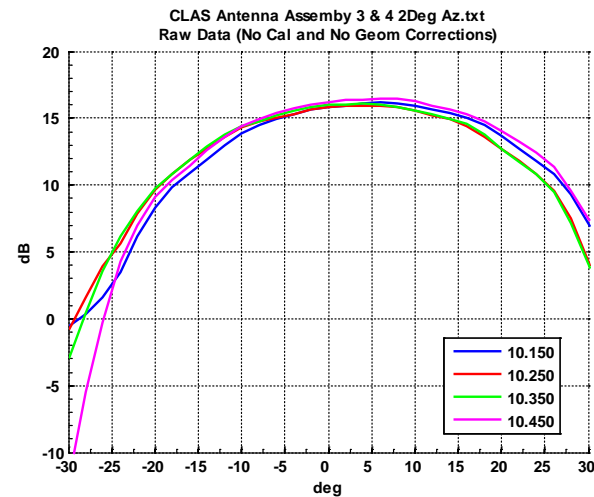
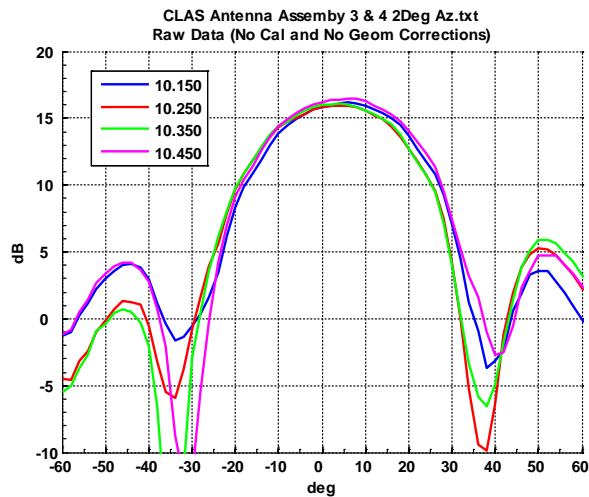
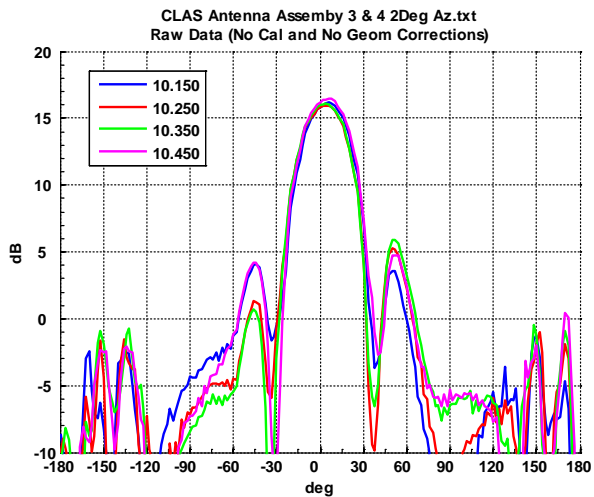
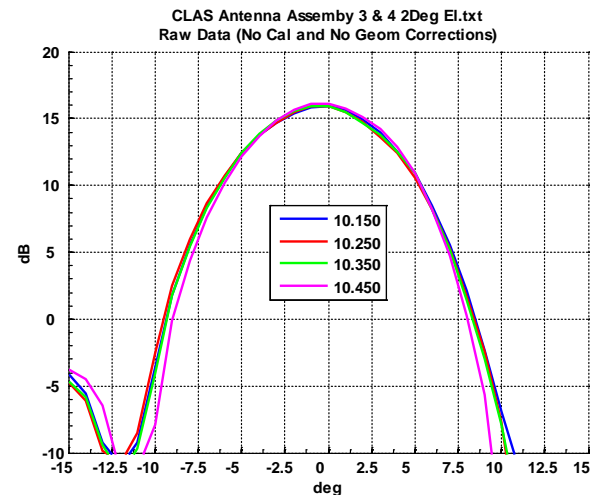
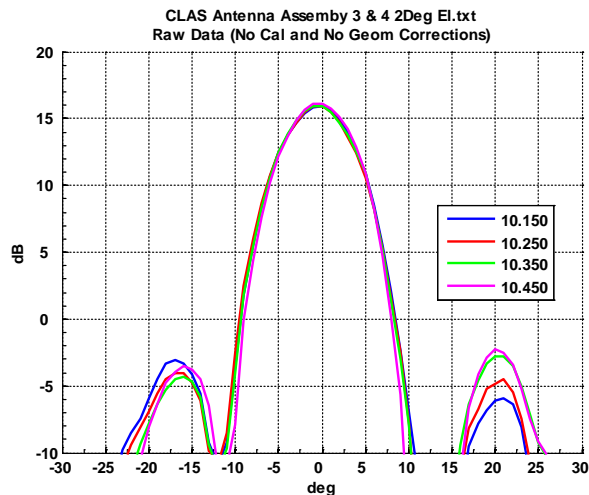
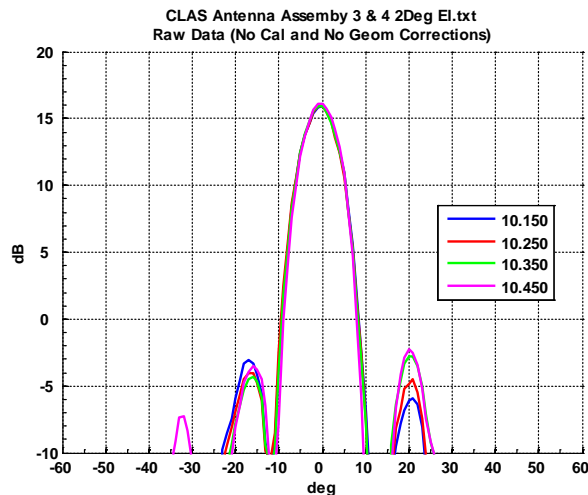
2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



4-Stick, **No RAM** (Sticks 1+2)

BRC NanoSAR Demo

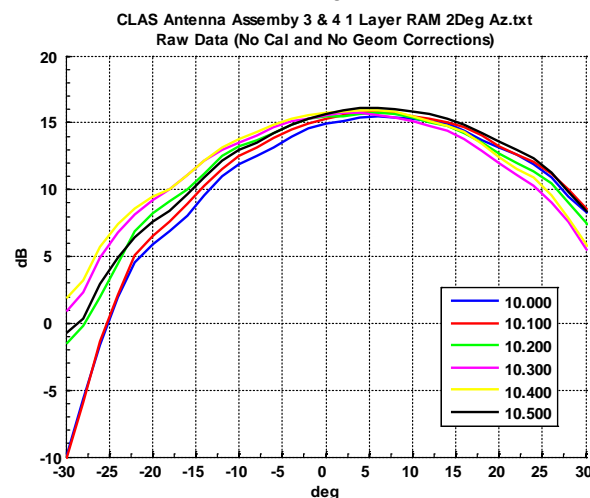
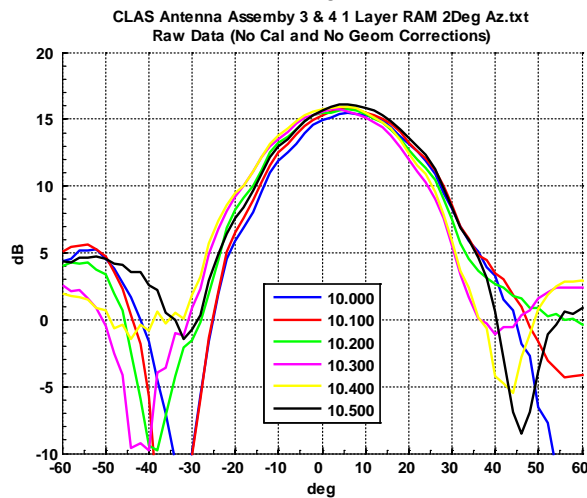
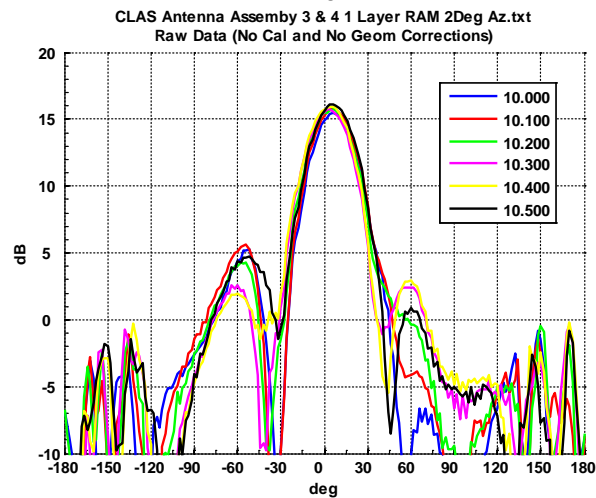
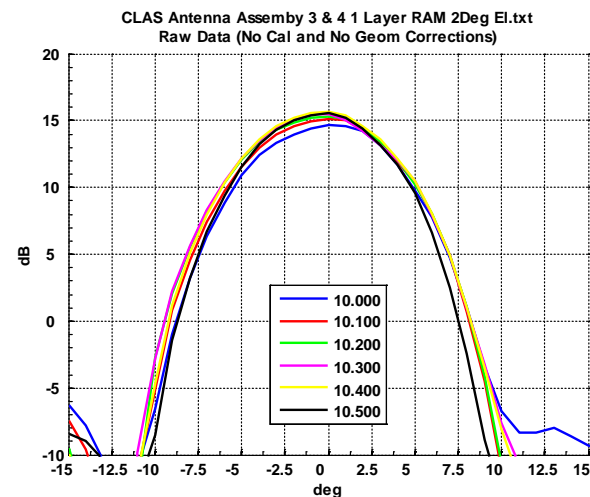
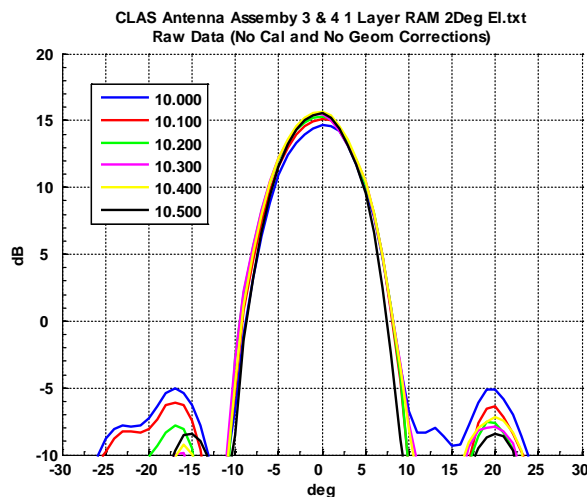
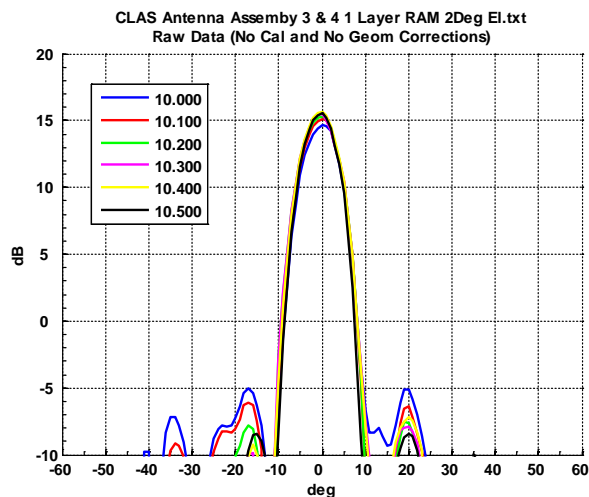
2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



4-Stick, *No RAM* (Sticks 3+4)

BRC NanoSAR Demo

2 Sock, Epoxy Loaded Slots (190 probes, additional cleaning, internal sanding)



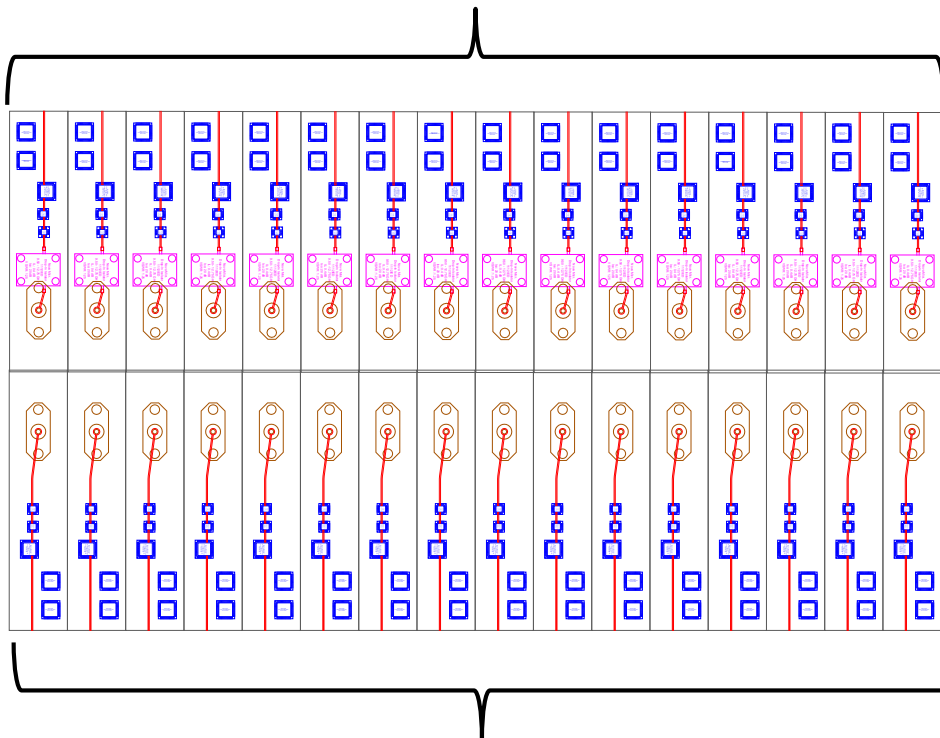
4-Stick, (Sticks 3+4 & 1 RAM Layer)

Sample Dual Slot Stick Configuration (Suitable for ImSAR Radar)

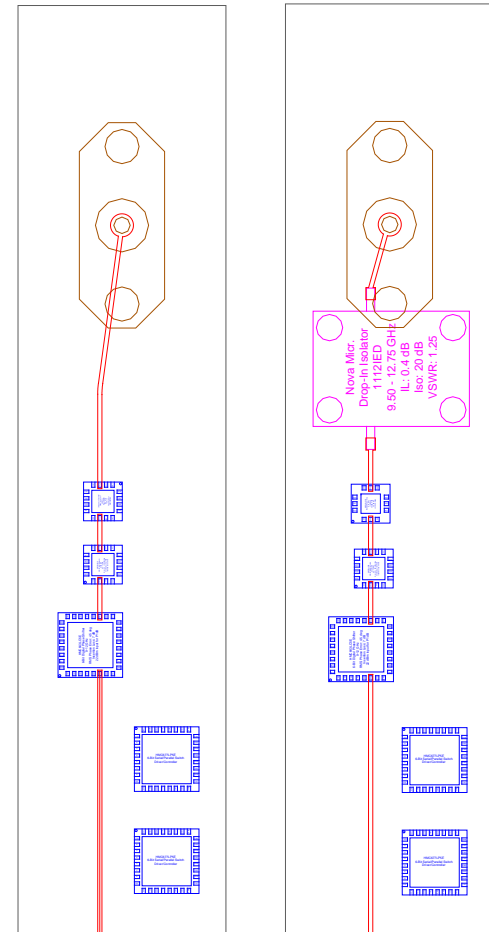
Substrate

- 10mil Thickness
- 13 mil Trace ($Z_0=51\Omega$)
- $Dk=6.15$ (e.g. Arlon TC600)
- ~ 0.38 dB Loss per inch

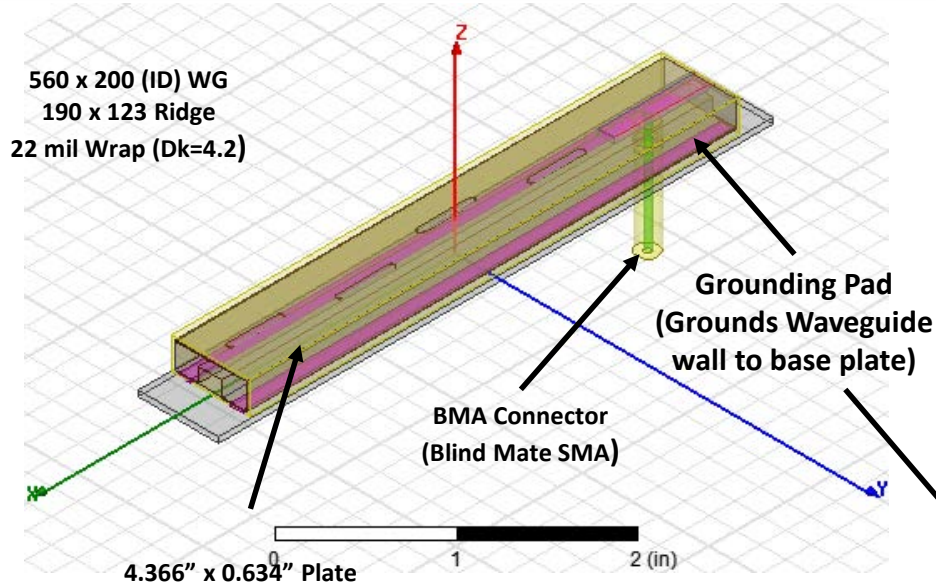
To 1:16 Tx Splitter



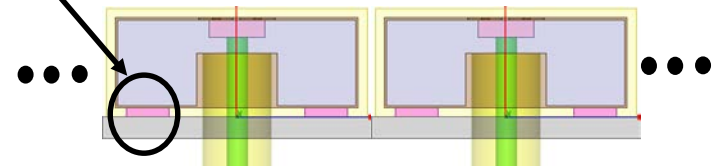
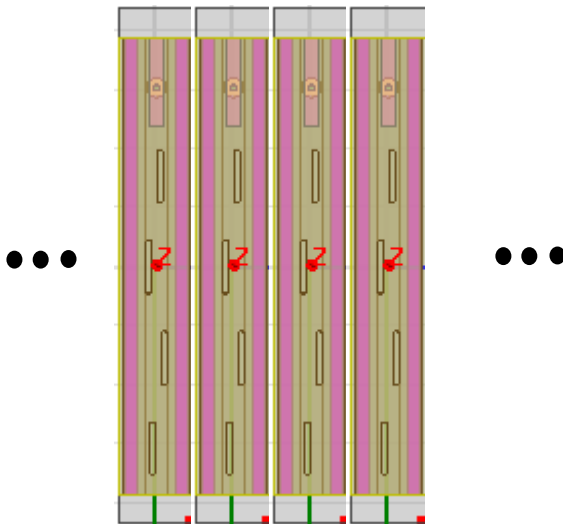
To 1:16 Rx Combiner



Quad Slot Sticks (16 Sticks)

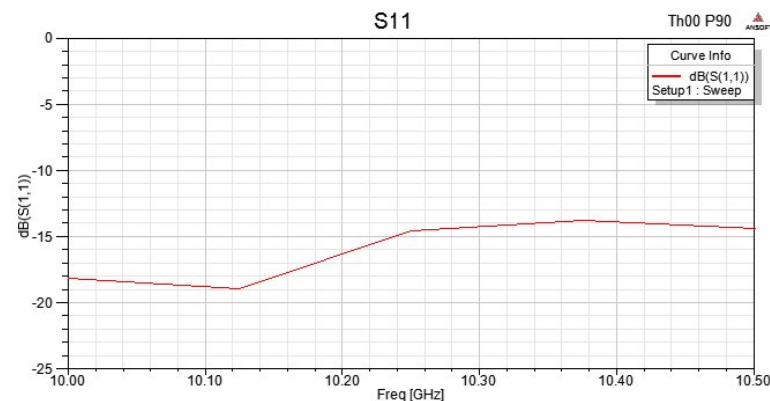
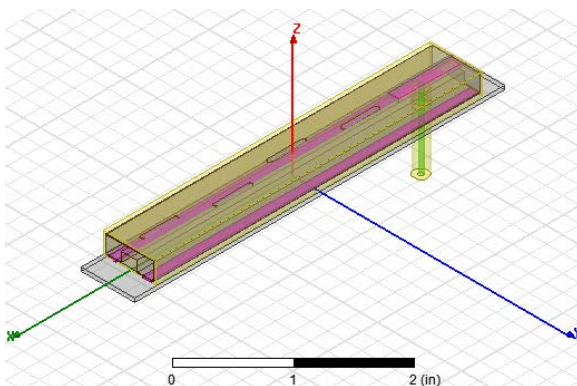


- Modeled as an 1-D infinite array (i.e. Finite in X and Infinite along Y). As such, the edge effects of a finite array along X is not modeled
- Patterns were computed assuming 16 sticks
- The metallic waveguide wall must be grounded to the mounting plate as shown below. Without the grounding the scan impedance varies rapidly with scan angle.



Grounding Pads (Grounds Waveguide wall to base plate)

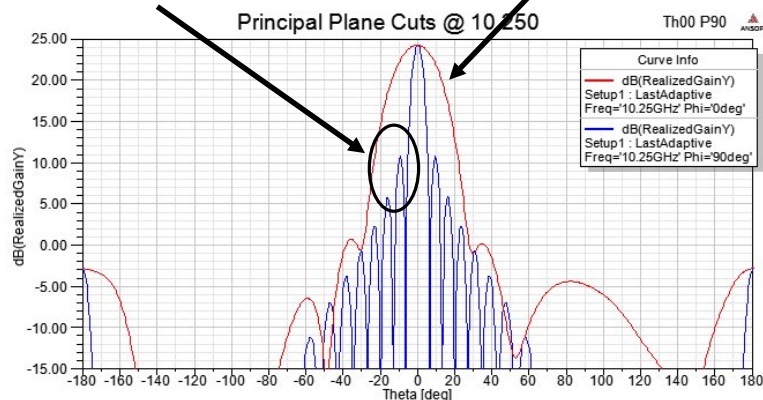
Quad Slot Sticks (16 Sticks) - 0° Azimuth Scan



Active Impedance (0° Azimuth Scan)

Azimuth Side Lobes can be reduced via controlling the stick-to-stick power levels.

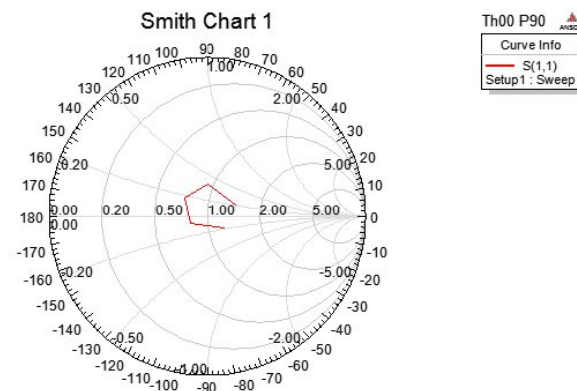
Elevation Pattern is likely too narrow for the ImSAR Radar



Principal Plane Patterns @ 10.250 GHz (0° AZ Scan)

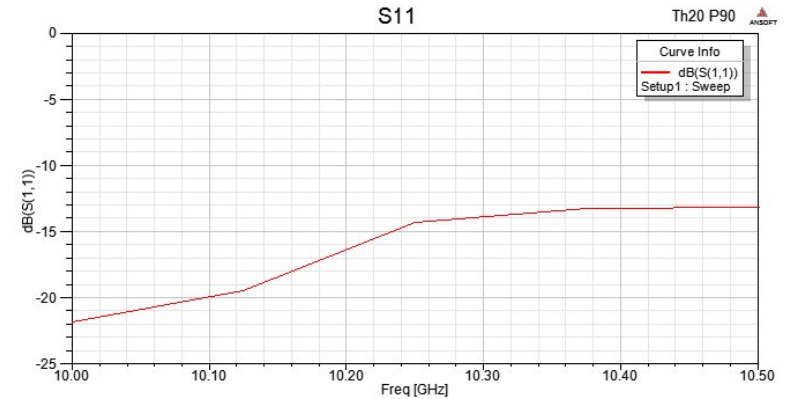
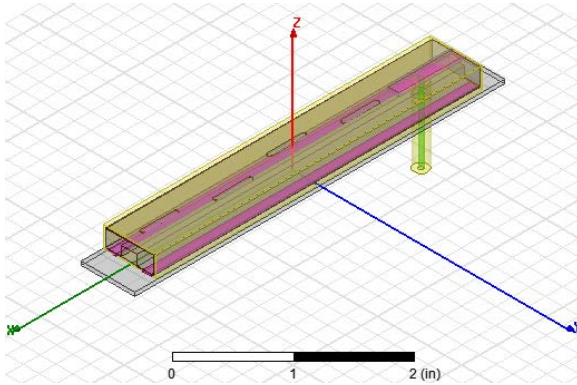
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

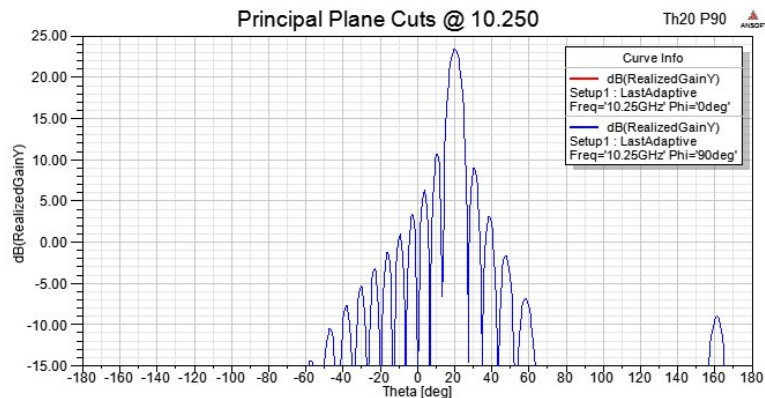


Active Impedance (0° Azimuth Scan)

Quad Slot Sticks (16 Sticks) - 20° Azimuth Scan



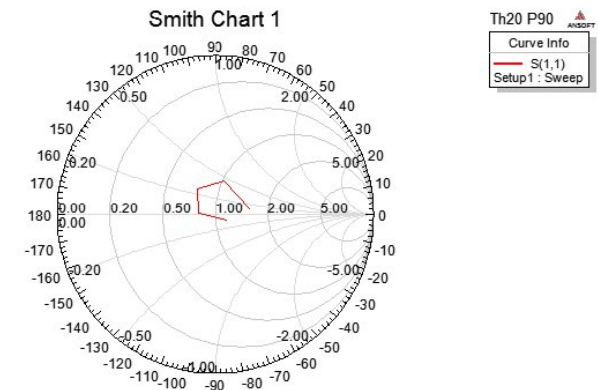
Active Impedance (20° Azimuth Scan)



Principal Plane Patterns @ 10.250 GHz (20° AZ Scan)

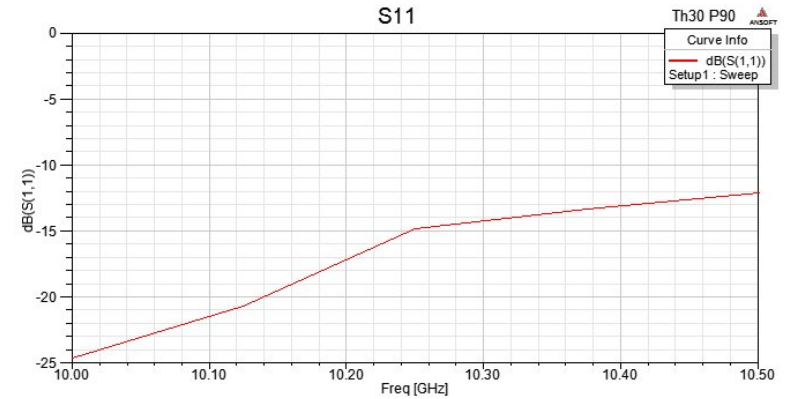
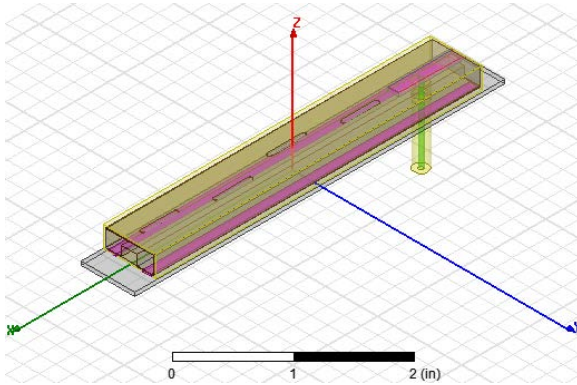
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

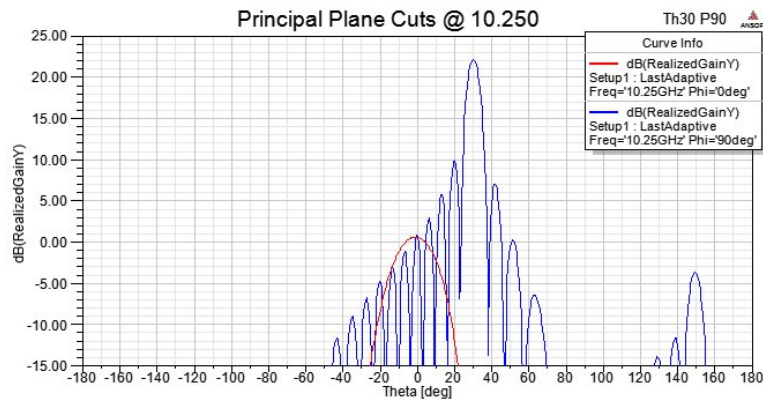


Active Impedance (20° Azimuth Scan)

Quad Slot Sticks (16 Sticks) - 30° Azimuth Scan



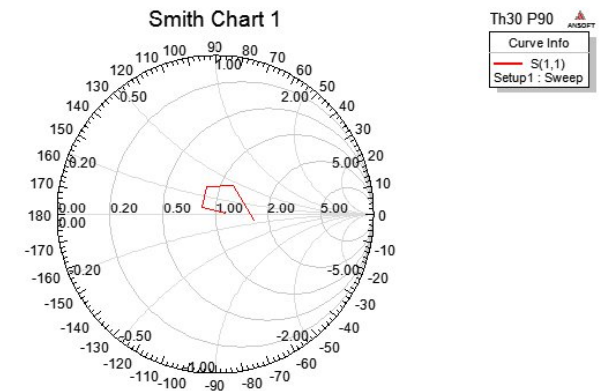
Active Impedance (30° Azimuth Scan)



Principal Plane Patterns @ 10.250 GHz (30° AZ Scan)

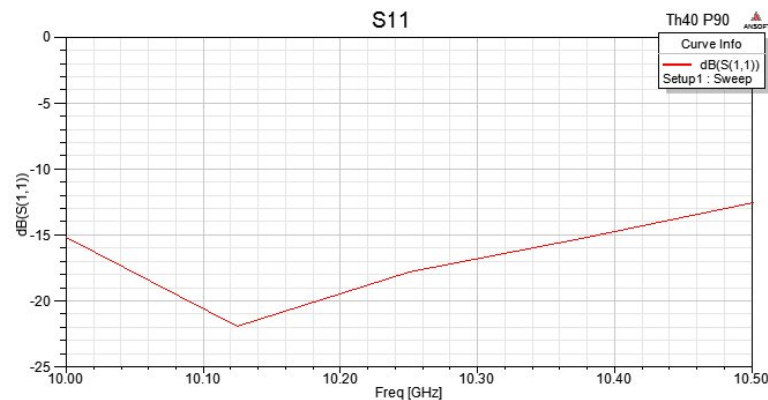
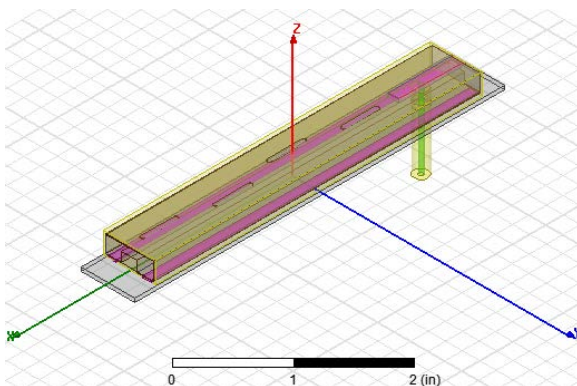
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

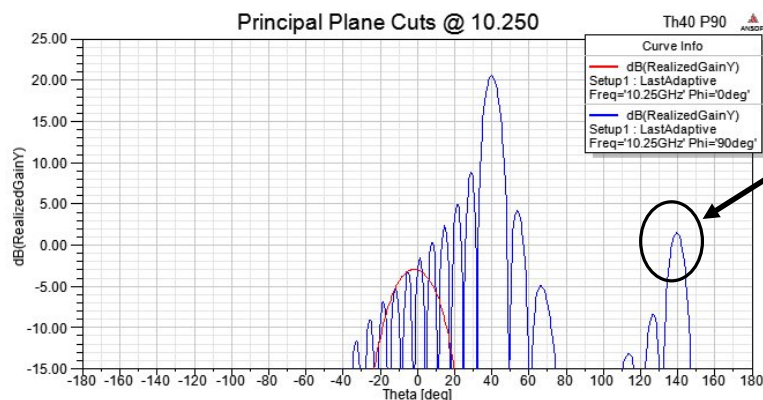


Active Impedance (30° Azimuth Scan)

Quad Slot Sticks (16 Sticks) - 40° Azimuth Scan



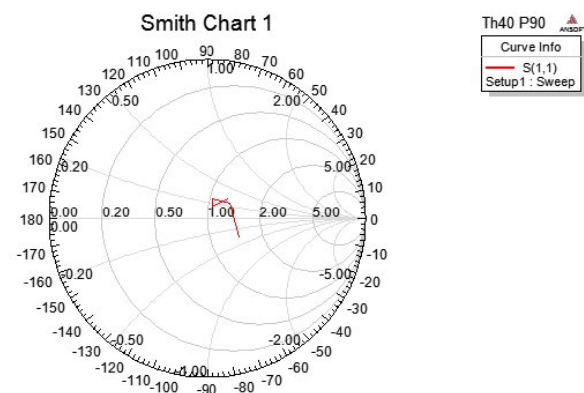
Active Impedance (40° Azimuth Scan)



Principal Plane Patterns @ 10.250 GHz (40° AZ Scan)

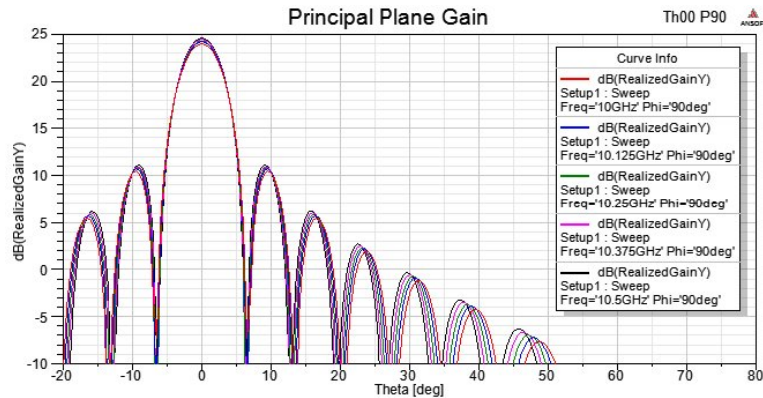
Red: EL (X-Z Plane) Blue: AZ (Y-Z)

Pattern assumes 16 Sticks

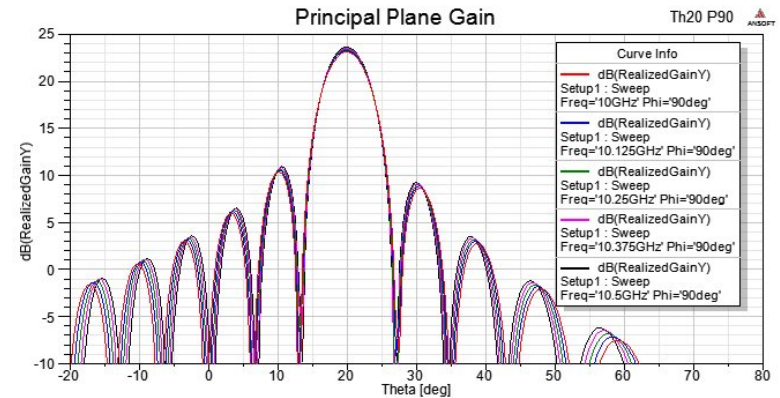


Active Impedance (40° Azimuth Scan)

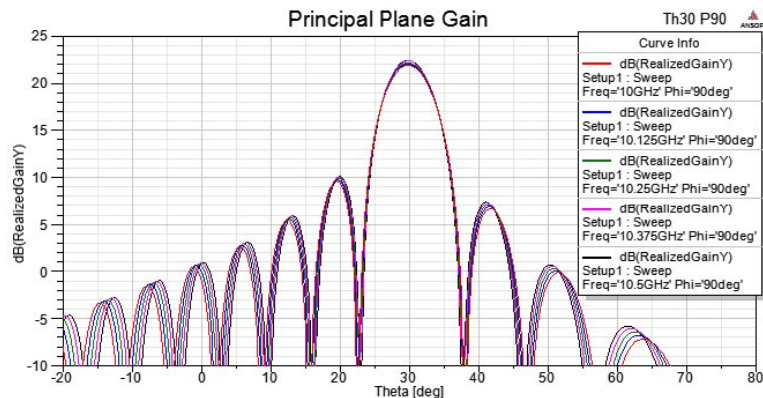
Quad Slot Sticks (16 Sticks)



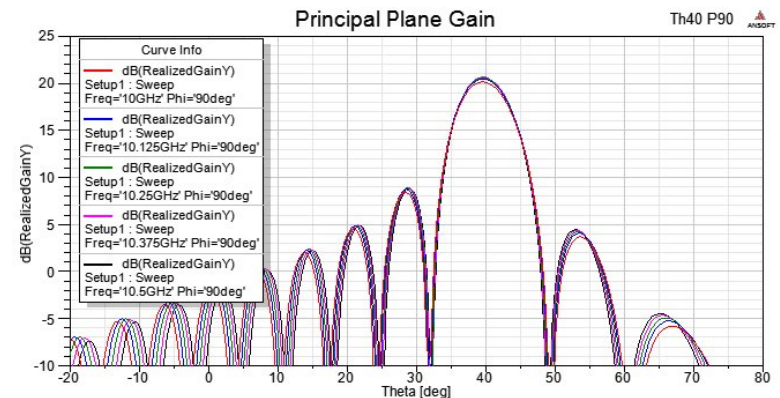
Azimuth Cuts at @ **0°** AZ Scan
Pattern assumes 16 Sticks



Azimuth Cuts at @ **20°** AZ Scan
Pattern assumes 16 Sticks



Azimuth Cuts at @ **30°** AZ Scan
Pattern assumes 16 Sticks



Azimuth Cuts at @ **40°** AZ Scan
Pattern assumes 16 Sticks